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INVENTOR(S)

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Additional inventors are being named on the second *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

TRANSFER DISPLAY FILM

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 12
☑ Drawing(s) *Number of Sheets* 3 (incl. in specification)
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☑ Other (specify) return postcard

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Respectfully submitted,

SIGNATURE [signature]

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Date August 2, 2004

REGISTRATION NO. 34,429
(if appropriate)
Docket Number: KENT.36969

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Docket Number KENT.36969

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Number 1 of 1

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Transfer Display Film

Background of Invention:
The following is background of the invention that includes prior work by the assignee. It should not be construed as an admission of prior art. Flat panel displays as they appear in the marketplace today are generally constructed on glass substrates. Liquid crystal displays (LCDs) that hold the greatest market share are fabricated with two glass substrates with liquid crystalline material sandwiched in between. In recent years there has been considerable interest in fabricating LCDs as well as other technologies on other types of substrate materials that are not so easily broken, are lighter in weight, and can be flexed or bent or made conformable to specific shapes. Unfortunately, most materials that have these properties do not have the convenient processing properties of glass, such as a high processing temperature or the ability to form smooth uniform surfaces on which to deposit the various coatings and liquid crystalline materials.

Substrates for displays typically need to have a flat uniform surface. In the case of liquid crystal displays, the substrate needs to be particularly smooth so that the spacing between the upper and lower substrate is uniform. Electrodes, often transparent conducting electrodes, on the upper and lower substrate are used to provide an electric field to drive the display. A uniform spacing between the electrodes is necessary to yield a uniform driving field throughout the display. Many desirable candidates for display substrates such as textiles, paper and numerous plastic sheets have rough surfaces and can only be processed at low temperatures or under unusual conditions to maintain their integrity.

For example, there are many display technologies for which it is inconceivable how to make an electrically addressed display on a rough surface such as a fabric. One approach discussed in a co-pending patent application by the assignee would be to add a planarization layer to smooth the rough surface; however, the type of layer would be different for different materials and surfaces. Likewise, the manufacturing process of a display is dependent on the characteristic of the substrate. The processing temperature can be very different from one substrate material to the next. Also, the type of equipment used to process the substrate could be very different for different materials. Substrates such as glass can be rigid and certain types of batch processing can be used where as many plastic materials can be very flexible, ruling out those types of batch processing but making continuous web processing possible. The current display industry is almost entirely based on glass substrates so that common processing equipment and procedures can be used, substantially lowering the cost of the product.

In this invention we disclose a new concept in display technology; a display that is a manufactured film. The film can operate as a free-standing film or it can be subsequently transferred to any desired substrate. This display is a stacked sequence of coated or printed layers that form a film with the elements of a reflective display including liquid crystal material, transparent conducting electrodes, insulation layers to prevent electrical shorts, and protective layers for ruggedness, all stacked together in a veneered film forming the framework of a display. The layers are each cast, in sequence, or

simultaneously on a release liner then lifted off of the release liner for transfer to some desired substrate. The display film can then be laminated on any desired surface, rough or otherwise, that can contain the interconnecting electrodes to the driving circuitry.

An advantage of this invention is that the manufacturing process is independent of the substrate unlike any display manufacturing process being currently used. A more significant advantage is that the display film may be laminated on any of a wide variety of substrates, such as cloth, which was not possible before. The substrate may possess a rough surface; however, the film can be laminated so that the electrode spacing is maintained and the display is functional so long as the surface does not rupture the display film. The display film can be made pliable and rugged and can be operable as a free-standing film even without a substrate. It can be stretched, rolled up, suitable for lamination on plastic, woven fabric material, etc or even specifically designed for lamination on an active matrix substrate.

The display film can be electrically addressed by adding suitable electrical interconnects to the substrate prior to or following lamination of the transfer display film. The electrical interconnects allow drive electronics to be connected to the electrodes of the display film. In some instances it may be possible to print some of the drive electronics directly on the display film. In other instances the display film may be laminated onto a substrate already containing some of the drive electrodes such as the column or row electrodes of a passive matrix or the pixel electrodes of an active matrix backplane.

A preferred display technology for fabricating a transfer display film is bistable cholesteric reflective technology. Cholesteric materials are particularly well suited for a display film in that they can be made as droplet dispersions that can be coated or printed and are self-sealing to contain the cholesteric liquid crystal in the film. Furthermore cholesteric materials are field driven requiring near negligible current to change their optical state. As such, the conducting electrodes can be such materials as conducting polymer or carbon nanotubes that can be printed or coated into a film. Other droplet dispersion systems such as nematics and ferroelectrics also offer the possibility for use as a transfer film.

Description of Invention:

We disclose display film comprising a stacked sequence of coated, printed or laminated layers with the elements of display film that can be transferred to a substrate, connected to electrical drive circuitry and electronically updated. A complete transfer display film including the liquid crystal material, transparent conducting electrodes, insulation layers to prevent electrical shorts, and protective layers for ruggedness can be all stacked together in a veneered film forming the framework of a display suitable for transfer to a substrate and connecting to drive electronics. The layers are each cast, in sequence, or simultaneously on a release liner then lifted off of the release liner for transfer to some desired substrate. The display film can then be laminated on any suitable surface, rough or otherwise that can contain the interconnecting electrodes to the driving circuitry. The electrodes can be added before or after lamination.

The display film can operate as a standalone or freestanding film with drive electronics attached directly to the film. This can operate without any substrate. With advent of printable electronics, all or part of the drive and control electronics may be printed directly on the film containing display film.

In some cases, it may be desirable for the transfer film to only contain a portion of the display for lamination on a substrate that already contains other display elements. For example the transfer film may contain one layer of printed electrodes, a liquid crystal droplet dispersion layer, and protective layer that is lifted off of a release liner then laminated on a substrate having the other conducting electrodes of a passive or active backplane.

A transfer display film as described above has the following advantages.

1. It can be laminated on a rough surface such as cloth, paper or other exotic substrates since the lamination process will not alter the uniform spacing between the electrodes.
2. The substrate on which the film will be laminated can be manufactured independently of the display film, making available a wide variety of materials or shapes not available for substrate use before.
3. The manufacturing facility of the display film can be simplified and of lower cost since it does not have to be specific to the substrate.
4. It can be laminated on substrates that otherwise could not contain a display in that they cannot be processed in a clean room environment.
5. The display film can be transferred to a backplane that contains a portion of the display elements and/or drive electronics such as, for example, an active matrix backplane or the row or column elements of a passively driven display.
6. The display film can operate as a free-standing film with electrical drive attached to the film or being a portion of the film.

The cholesteric display technology is well suited for this veneer type film construction.

1. Cholesteric materials can be easily prepared in droplet dispersion making them suitable for coating. A variety of dispersion processes are available for this.
2. Cholesteric displays are a field driven display (as opposed to a current driven display) making them adaptable to coated or printed transparent conducting materials such as conducting polymers or carbon nanotubes that generally possess low transparency/conductivity ratios.
3. The cholesteric technology is a stackable technology in that a layer of cholesteric droplet dispersion will reflect only a preselected wavelength and band width and is transparent to other wavelengths allowing a reflective display that utilizes the entire area of the display as a reflection surface making maximum use of available light for brightness. This feature also allows use of a photoelectric cell as the substrate to manufacture a self powered display or a display surface that can function as a display or photocell to generate electric power.
4. Cholesteric materials can be tuned to reflect at any desired wavelength (color) and bandwidth for full color displays with stacks of the primary colors RGB.

One embodiment of this invention is monochrome bistable cholesteric reflective display film that can operate as a freestanding film or be transferred to fabric, polymer, or other substrate that may be opaque. Figure 1 shows a film stack, 100, that illustrates the various layers that make up the film. The film is fabricated by casting each of the layers on a surface that can serve as a release liner in the following sequence:

1. A casting layer, 101, is first coated or laminated onto the release liner. The casting layer serves several purposes. It first of all is a film that, once dried or cured can be removed from the release layer. Secondly, it provides a suitable surface for wetting the next coating in the sequence which can be an opaque layer to serve as a dark background or if a dark background is not used the second layer may be one of the display electrodes. The casting layer is sufficiently rugged to be lifted off the release liner and subsequently laminated on a substrate.
2. A light absorbing layer, 102, usually black in color, is then coated onto the casting sheet. The light absorbing layer adheres to the casting sheet and, in this embodiment, serves to absorb unwanted light passing through the cholesteric liquid crystal layer, 105. In this embodiment, the resulting display is to be observed from the upper surface, 108. The material of the light absorbing layer serves to wet the next coating in the sequence, the lower conducting electrode.
3. A conducting electrode, 103 is then coated or printed on the dye layer. In this embodiment, the conducting material does not have to be transparent but is desired not to be reflective. Carbon based materials, such as conducting polymers are suitable as long at they provide sufficient conductivity; for example, less than 1000 Ohms/square resistivity, a parameter also controlled by the thickness of the layer. Carbon based materials can also be of interest in that, often they can be printed to form a desired electrode pattern.
4. An insulation layer, 104, is advantageous over the conducting electrodes to prevent electrical shorting. However, if the cholesteric liquid crystal is dispersed in a binder that is, in itself sufficiently insulating, this insulation layer may not be used. It is desired that the insulation layer be less than 1.0 microns thick in order to maintain suitable drive voltages.
5. A cholesteric liquid crystal dispersion layer, 105, is then coated over the insulation layer. The liquid crystal dispersion material can be made from any of several different processes such as, an emulsion, phase separation, or microencapsulation process. A preferred process is a dispersion prepared from latex emulsion since these binders possess desired wetting and adhesion properties for coating. For the cholesteric liquid crystal, the droplet size should be large enough, for example, greater than 1.0 micron to allow bistability. The thickness of this coating determines the drive voltage of the display as well as the display brightness. To optimize brightness, it is desired that this layer be at least 4.0 microns in thickness; however, to maintain moderate to low drive voltages, less that 15 microns depending on the physical properties of the liquid crystal material.
6. A second insulation layer, 106, may be advantageous to prevent electrical shorts. This layer may also serve as isolation or wetting layer for the top clear coat.
7. A transparent conducting layer, 107, is then printed or coated and suitably patterned to serve as the upper electrode. Transparent conducting polymers or

carbon nanotubes are materials suitable for this purpose. The transparency to conductivity ratio depends on the thickness of the coating. If the response speed of the display is not an issue, a resistivity as high as a few thousand Ohms/square has been found suitable.

8. A clear protective layer is advantageous in ruggedizing the display and protecting it from the environment.

Figure 2 illustrates the process of lifting off the film from the release liner, 210 then laminating the film on a substrate, 211.

Another embodiment of a monochrome reflective display is one that is laminated on a clear substrate such as a transparent polymer or glass. In this case, there is no dyed light absorbing layer and the lower conductor is a transparent conductor or may not be part of the transfer film if the lower conductor is on the substrate. The upper conductor may be an opaque conductor and the clear coat is replaced by a black coat.

Another embodiment of this invention is to laminate the transfer film with the film upside down; that is with the side of the protective coat adjacent to the substrate. In this embodiment the protecting coat is replaced with a preparation coat that may also serve as an adhesive or serve to hold an adhesive layer. If the substrate is not transparent, it may be desirable that the preparation layer is dyed to absorb light over some spectral band width and that the light absorbing layer, 101, be removed. Furthermore the lower conducting electrode would be a transparent conducting electrode.

Another embodiment of a monochrome cholesteric reflective display is one that is of full reflective brightness, reflecting more than 50% of incident light. In this embodiment, the liquid crystal dispersion layer is made up of two coatings, one of a left hand twist cholesteric liquid crystal and the other of right hand twist cholesteric both tuned to the same pre-selected wavelength and bandwidth. Stacked cholesteric layers of opposite handedness reflect both components of circular polarized light and as such can, theoretically, reflect all of the incident light at the Bragg wavelength of the films. Practically, some light is lost to scattering for defects in the dispersion and unwanted reflections and absorptions from the other layers in the stack. The total reflection can approach 80% of incident light. Instead of two separately coated layers, left and right handed microencapsulated droplets may be cast as one coating.

A full-color, single reflective dispersion layer is possible if the droplet dispersion layer is patterned with red (R), green (G) and blue (B) pixels for additive color mixing. The film is similar to item 1, (The Standard Monochrome) film except that the droplet dispersion has been patterned by a process such as UV radiation of cholesteric material with a UV sensitive twisting power as disclosed in U.S. Patent 5,668,614, which is incorporated herein by reference in its entirety.

Another full-color embodiment can be fabricated by replacing the single cholesteric dispersion layer, 105, with a three layer RGB stack with conducting electrodes in between each layer. Such a display is addressed by a shared electrode addressing scheme

possible with bistable cholesteric dispersions. Added brightness may be achieved if each of the R, G and B layers contains a stacked left twist and right twist dispersion layer. An upper clear protective coat may be used.

An infrared reflective display is another embodiment in a veneered display film such as those above but with at least one of the droplet dispersion layers reflecting in the infrared such as might be used for night vision purposes.

A self-powered display may be achieved by laminating transfer display film on a solar panel whereby light that is not reflected by the cholesteric material can be absorbed in the solar panel for conversion into electrical power for powering the display. One such transfer film could be that of Fig.1 where the dye light absorbing layer,102, is eliminated to increase the efficiency of the solar panel.

An optically addressed transfer film is achieved by eliminating the lower conducting electrode, 104, as well as the dyed light absorbing layer and transferring the display film to a photoconductive sheet with an electrode underneath. With a continuous voltage applied to the electrodes, light impinging the display film will locally alter the resistivity of the photoconductor and drive the display film. The display can be addressed with an image suitably focused on the film, or written with a scanned laser beam.

Not to be limited by these examples, other veneered stacks are possible depending on the desired display.

Examples:

Example 1: An operable 16x16 pixel passive matrix, free-standing cholesteric display film was made by first coating and printing the various display elements on a release liner to form a display film, then lifting the film off of the liner for subsequent lamination on a substrate. The release liner was a neoprene sheet with a fabric support available from Thor Labs (Newton, NJ). A casting layer of aqueous polyurethane dispersion (WITCOBOND W232 available from Crompton Corporation, CT) was deposited on the release liner using a Meyer rod technique and allowed to dry at room temperature. The dry thickness of the casting layer was approximately 10-12 microns. A layer of conductive polymer (ELP-3040 available from Agfa-Gevaert, Belgium) was screen printed on the casting layer as 5mm wide, 15 cm long strips spaced 1mm apart to serve as the column electrodes of the passive matrix display. After casting the conducting polymer was cured at 100°C for 10 minutes. The thin insulation layer (1-2 microns) of the polyurethane dispersion (WITCOBOND W232) was cast on the conductive layer using a doctor blade technique. A layer of dispersed cholesteric liquid crystal in polymer binder was coated from water-based emulsion on the insulation layer using a doctor blade having a 25 micron gap and allowed to dry for 1 hour at room temperature. The thickness of the dispersed liquid crystal layer was approximately 8-10 microns. The ratio between liquid crystal and binder was from 4:1 to 5:1. The emulsion was prepared from 0.4 g of CLC KLC19 (EM Industries of Hawthorne, NY) and 0.27 g of NeoRez R967 available from NeoResins, MA, emulsified with a homogenizer (PowrerGen 700) at 1000 rpm for 3-4 min at room temperature. Emulsified CLC formed droplets which are about 3-15

microns in diameter. A second conductive electrode was a highly transparent conductive polymer Dipcoat available from Agfa. A thin layer of conductive polymer was deposited using air brushing over a mask and cured at room temperature. The mask was patterned to provide 5mm wide, 15 cm long strips spaced 1mm apart to form the row electrodes of the passive matrix display. For protection of the display, a, clear coat was deposited on the top of the second conductive electrode using a doctor blade. Moreover the use of the transparent layer of WITCOBOND W232 with thickness approximately of 5-10 microns as a clear coat allowed one to increase the transmission due to the refractive index matching.

The display film including all of the layers from the casting layer to the clear coat was lifted off from the release liner. The thickness of the free-standing display was around 25 microns and could be electrically addressed by applying the appropriate voltages to the column and row electrodes. The bistable cholesteric material could be addressed to the planar (yellow reflective) by application of 135 volts or to the focal conic (non-reflective) texture with application of 105 volts. Pixels addressed to the planar and focal texture would remain in their respective state even if the film were bent, twisted, folded, and even stretched. The display film has contrast ratio of 12:1 and brightness of 28%. The display film was very rugged and suitable for lamination on a substrate without damage. In this particular example, it is desired that substrate be opaque and preferably black so that the focal conic state appears black and reflective planar state appears a bright yellow and highly contrasting against the black.

<u>Example 2:</u> An operable 16x16 pixel passive matrix, transfer cholesteric display film was made by first coating and printing the various display elements on a release liner to form a display film, then lifting the film off of the liner for subsequent lamination on a substrate. The sequence of the materials layers is the same as in the Example 1 except that insulation layer was made of polyurethane dispersion NeoRez R967.

<u>Example 3:</u> The following is an example of preparation of the stacked layers of materials for a transfer display film from a release liner with adhesive and casting layers. As illustrated in Figs. 3 and 4, an operable 4x1 pixel direct driven, transfer display film was made by first coating and printing the various display elements on a release liner to form a display film, then lifting the film off of the liner for subsequent lamination on a substrate. The release liner was the same as in Example 1. The casting layer is a 25 micron polycarbonate plastic sheet laminated with a pressure sensitive adhesive layer. The sequence of the material layers is similar to that in the Example 1 with exception of the casting and adhesion layers. Following the coating and drying of the layers the display film with the adhesion layer to the clear protective coat was lifted off of the release liner and laminated to the black soft cloth. The display was fully operational after transfer to the final substrate. The bistable cholesteric material could be addressed to the planar (yellow reflective) by application of 110 volts or to the focal conic with application of 55 volts. The display film has contrast ratio of 13:1 and brightness of 30%.

Example 4: The following is an example of preparation of the stacked layers of materials for a transfer display film on a release liner with an adhesive and casting layer.
The display has the same sequence of the material layers as in the Example 2 except that the release liner was a paper sheet with peel off adhesive transparent layer (Avery laminating sheets 73602). In order to establish a black background for the reflective display a black paint (KRYLON) was first coated on the substrate by spraying and dried at room temperature. A 2x2 pixel display was prepared as follows. First, the layer of conductive polymer (ELP3040) was deposited with Meyer rod on the black paint and cured at 80°C for 15 minutes. Next, a layer of dispersed liquid crystal and second conductive electrode were deposited the same way as it is described in Examples 1 and 2. The display did not have a clear coat layer as a top layer. The display film has a contrast ratio of 18:1 and brightness of 34%. The driving voltage for planar state was 95 V and 60 V for focal conic state.

Figures:

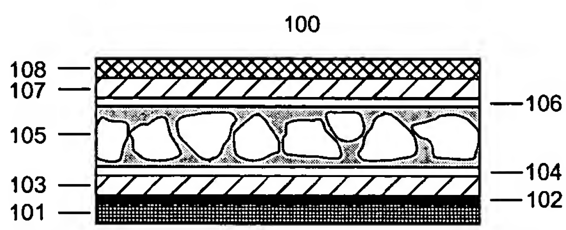

Fig. 1:

100. Free-standing display transfer film
101. Casting layer
102. Dyed light absorbing layer
103. Conducting electrode layer
104. Insulation layer
105. Liquid crystal dispersion layer
106. Insulation layer
107. Transparent conducting electrode layer
108. Clear protective layer

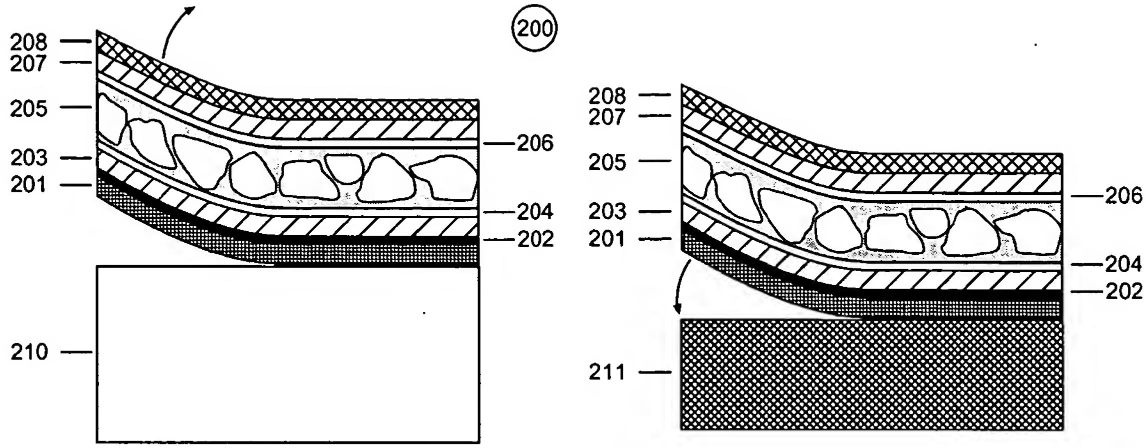

Fig 2

200. Illustration of a free-standing display transfer film being lifted off a release liner, 210 for transfer and lamination on to a substrate, 211.
201. Casting layer
202. Dyed light absorbing layer
203. Conducting electrode layer
204. Insulation layer
205. Liquid crystal dispersion layer
206. Insulation layer
207. Transparent conducting electrode layer
208. Clear protective layer
210. Release liner
211. Substrate

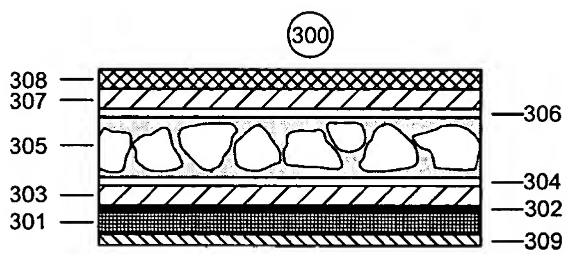

Fig. 3:

300. Free-standing cholesteric display film with adhesive layer
301. Casting layer
302. Dyed light absorbing layer
303. Conducting electrode layer
304. Insulation layer
305. Liquid crystal dispersion layer
306. Insulation layer
307. Transparent conducting electrode layer
308. Clear protective layer
309. Adhesive layer

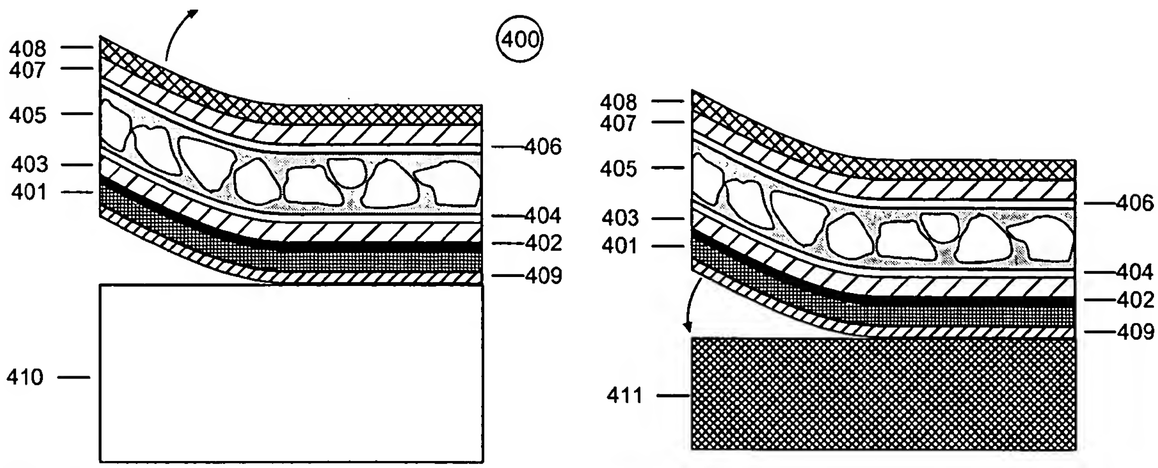

Fig. 4:

400. Illustration of a free-standing display film with adhesive being lifted off a release liner, 410, for transfer and then laminated on to a substrate, 411.
401. Casting layer
402. Dyed light absorbing layer
403. Conducting electrode layer
404. Insulation layer
405. Liquid crystal dispersion layer
406. Insulation layer
407. Transparent conducting electrode layer
408. Clear protective layer
409. Adhesive layer
410. Release liner
411. Substrate

Background Art:

<u>Cholesteric display technology</u>

- US Patents 5,437,811 and 5,691,795 (Kent State University—polymer containing)
- US Patent 5,453,863 (Kent State University---polymer-free)

<u>Cholesteric drive circuitry and schemes</u>

- US Patent 5,644,330 (KDI conventional drive)
- US Patent 5,748,277 (KSU dynamic drive)
- US Patent 6,133,895 (KDI cumulative drive)

<u>Droplet dispersions</u>

- US Patent 6,061,107 (Kent State University)
- Drzaic, P. (1995) Liquid Crystal Dispersions, World Scientific Publishing Co. Singapore
- Doane, J.W. (1990) in *Liquid Crystals: Applications & Uses* (ed. B. Bahadur), World Scientific Publishers, Chapter 14

- US Patent 6,556,262 B1 (Kodak)
- US Patent 6,423,368 B1 (Kodak)
- US Patent 6,359,673 B1 (Kodak)

Flexible displays and web manufacturing

- US Patent Application Publication US 2003/0202136 A1 (Kodak)
- US Patent Application Publication US 2003/0117548 A1 (Kodak)

Claims:

1. A transfer display film, comprising a stacked sequence of layers prepared on a release liner and lifted off as a freestanding display film or for transfer to a substrate, said display film operable as an electrically addressable display when connected to drive electronic circuitry.
2. A transfer display film as in Claim 1 where each of the layers are coated, printed, or laminated on a release liner in the sequence of a casting layer, lower conducting electrode, electro-optic layer, and upper conducting electrode in a veneered stack to form the basic elements of an operable display.
3. A transfer display film of Claim 2 where the electro-optic layer is a liquid crystal dispersion, preferably a cholesteric liquid crystal dispersion.
4. A transfer display film of Claim 2 where at least one the conducting lower or upper electrodes are a transparent conductor, preferably a conducting polymer or carbon nanotube material printed or coated and patterned to form the desired electrode configuration.
5. A transfer display film of Claim 2 where an insulation layer is coated, printed or laminated over the lower conducting electrode layer.
6. A transfer display film of Claim 2 where an insulation layer is coated, printed or laminated over the electro-optic layer.
7. A transfer display film of Claim 2 where an optical layer is coated over the casting layer to adjust optical properties of the transfer film such as to absorb unwanted light or index match succeeding layers.
8. A transfer display film of Claim 2 where a protective layer is coated over the upper electrodes.
9. A transfer display film as in Claim 8 where the protective layer is optically clear and the film laminated or otherwise transferred to a substrate with the casting layer nearest the substrate to operate as a reflective display.
10. A reflective display of Claim 9 where the casting layer is coated, printed or laminated over an adhesive layer that lifts off the release liner with the casting layer.
11. A reflective display of Claim 9 or 10 where the substrate is a fabric material of natural or synthetic fibers produced by knitting, weaving, pressing or other means to form a flexible sheet.
12. A transfer display film as in Claim 8 where the protective layer is optically opaque and the film is laminated or otherwise transferred to a transparent substrate with the casting layer nearest the substrate to operate as a reflective display.

13. A transfer display film of Claim 1 where a preparation layer is coated over the upper conducting electrodes, said preparation layer being an adhesive layer or serving to hold an adhesive overcoat; said display film laminated or otherwise transferred to a substrate with the preparation or adhesive layer adjacent the substrate to operate as a reflective display.

14. A reflective display of Claims 2, 9, 10, 11, 12, or 13 where the electro-optic layer is a stack of sublayers of cholesteric liquid crystal dispersions each reflective at a different wavelength and each separated with a transparent conducting electrode.

15. A full-color display of Claim 14 wherein the stack of sublayers of the cholesteric liquid crystal dispersions comprises one sublayer reflective in red, another sublayer reflective in blue and another sublayer reflective in green.

16. A night vision display of Claim 14 wherein at least one of the cholesteric layers in the stack is reflective in the infrared.

17. A transfer display film as in Claim 2 wherein the cholesteric dispersion layer is a layer made up of left and right hand twist cholesteric materials, separated to prevent mixing.

18. A transfer display film of Claim17 wherein the cholesteric dispersion layer is a double coating, one of left and the other of right hand twisted cholesteric materials.

19. A reflective display of 2, 9, 10, 11 and 13 where the display transfer film is laminated on a solar panel to provide a self-powering display.

20. A transfer display film, comprising a stacked sequence of layers comprising at least one conducting electrode layer and a cholesteric dispersion layer prepared on a release liner and lifted off for transfer to a substrate, said display film and substrate together operable as an electrically addressable display when connected to drive electronic circuitry.

21. A transfer display film of Claim 20 wherein the substrate contains a photovoltaic and a conducting layer to form an optical addressable display.

22. A transfer display film of Claim 20 wherein the substrate is an active matrix backplane to provide an actively driven display.

23. A transfer display film of Claim 20 wherein the substrate contains either the row or column electrodes to form a passively driven reflective display.